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CENTRAL SIBERIA -- A BASE FOR PRODUCTION OF FERROUS AND NONFERROUS MATERIALS

I. N. Plaksin
 Corresponding Member, Academy of
 Sciences USSR, A. V. Troitskiy
 mining engineer

Today Central Siberian ores (Novosibirsk and Kemerovo oblasts, Altay Kray) occupy a prominent place in Soviet metallurgy. The ores are characterized by their polymetallicity and complexity of composition. For example the ores which are obtained from the Salair region contain lead, zinc, copper, gold, silver, cadmium and barite. Ores from Kolyvan and Beloretsk contain wolfram, molybdenum, bismuth, silver. The iron ores which are obtained from Temir-Tau and Sheregesh contain zinc and other nonferrous metals in addition to iron. These deposits are both of the basic and alluvial types; the latter type is well known for its richness of tin, wolfram, mercury and gold.

The natural resources of Central Siberia also contain many of the so-called supplementary raw materials, such as clay, quartzites, quartz sands, and refractory clay. This fact, together with the physical proximity to the Kuznetsk coal fields, presents all the factors necessary for a large and productive metallurgical industry.

Unfortunately, however, the authorities have as yet not fully realized the full importance of this situation; moreover, the deposits are being worked by methods which are in dire need of modernization. Thus, the major problem seems to be the introduction of efficient exploitation methods which would fully utilize the mineral deposits. It is particularly necessary to improve the present technology utilized in ore dressing. Moreover, the stable nature of the ores permits the use of only one method of dressing (they are characterized by low concentration and poorly metamorphosed complexes). However, this advantage was not fully exploited, and until recently ores from basic deposits were transformed into a conditioned concentrate, regardless of whether the ore was ferrous or nonferrous.

- 1 -

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The dressing technology for ferrous and rare metals obtained from basic deposits involved flotation, gravitation or a combined method which was based on a selective separation of the minerals. These methods lead to excessive wastes. The new methods for dressing should take into account generic relationships of the metals.

As is well known, the production of the iron ore deposits Temir-Tau and Tashtagol does not meet the requirements of Kuznetsk metallurgical furnaces. Supplementary ores are shipped in from Magnitka. However, a comprehensive analysis has shown that all the needs of Kuznetsk metallurgical combines can be filled from local sources. It has been recommended that no time be lost in reconstructing and putting back into modernized operation the iron ore deposits at Temir-Tau. All the ores which are obtained from Gornyye Shchrii and Abakan, Khakassko-Minisinskiy Krav, must be dressed prior to use. Supplementary ores, like manganese, will be supplied by the reconstructed Mazul' and the new Usinsk deposits; flux clays will be supplied by the reconstructed Karachkinsko-Tolstochikhinskiy deposits; quartzites from the Chugunashkiy deposits; quartz sands from the reconstructed Lomachevskiy deposit, and mold sands from the Belovo deposits. Every one of these "local" deposits has untold exploitation and expansion possibilities.

The iron ore deposits of Central Siberia are characterized by complex chemico-mineralogical composition, as well as a considerable intermixing of industrially acceptable and nonacceptable ores. The ores can be divided into two classes: one primary and two oxides. The most frequent representative of the former is magnetite, while semimartite and limonite (in rare cases martite) are good representatives of the oxide group. The most common member of the sulfide group is pyrite, and to a lesser degree pirrotin, sphalerite, copper and lead sulfides. Due to the very favorable compounds of $\text{SO}_2 + \text{Al}_2\text{O}_3$ and $\text{Ca} + \text{MgO}$ they are very easily smelted.

Today, minimum industrial standards call for 30 percent iron content in ores. However, with modern dressing technology, this minimum could be lowered to 25 or 20 percent, thus greatly increasing the extent of known deposits. A solution to the problem of lowering the minimum standards would have a very important significance in the national economy.

The sulfur (one to three percent) found in Central Siberian deposits in the form of sulfides, is extracted by magnetic separation. But on the other hand this leads to a considerable waste in nonferrous metals which are generally present in ores in the form of sulfides. It is therefore of major importance that various deposits make use of new technological methods which have been developed by Mekhanobr (Scientific Research Institute for Mechanical Processing of Useful Minerals) for some Central Siberian ores, particularly those obtained from Abakan and Sheregesh. It has been shown that a 0.1 to 0.15 percent zinc content in iron ores has a detrimental effect on the performance of blast furnaces. Modern dressing technology practiced at Kuznetsk dressing plants does not lower the zinc content below 0.5 percent thus leading to undesirable consequences. The problem was assigned to the Ural Scientific Research Institute Mekhanobr, and it has determined that one of the first steps to take would be to grind the ore to 35-48 mesh dimensions. The crushed material is then subjected to flotation and magnetic separation. The tailings which contain both zinc and iron concentrate are easily extracted. Thus iron ores which contained 48.33 percent iron and 1.57 percent zinc, after crushing to 35 mesh dimension, gave the following results: iron concentrate which contained 69.19 percent iron and 0.1 percent zinc after extraction yielded 94.28 percent iron, while zinc concentrate which contained 49.8 percent zinc and 10.99 percent iron after extraction yielded 77.17 percent zinc. In addition to material obtained in the tailings there was an industrially acceptable mixture containing 28 percent zinc which after extraction yielded 13 percent zinc.

- 2 -

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50X1-HUM

The zinc content in concentrate can be greatly reduced by crushing ore to 150 to 250 mesh dimension prior to magnetic separation. This, however, is only a very poor method for solving the difficulty. It has been shown that the utilization of a complex dressing method gives best results with Central Siberian ores of high zinc content. This method, complemented by flotation, has done much to increase the efficiency of blast furnaces, cut repairs, and improve the smelting of iron concentrate. It will also permit shipments of local zinc ores to the Belovo Zinc Plant and provide a considerable amount of sulfides which can be well used in the production of sulfur, copper and other rare metals.

Thus it can be concluded that the dressing technology best suited for Central Siberian ores should be based on a flotation extraction with end processing of the collected concentrate, as well as the tailings to permit separation of both select and high-quality iron, zinc and other concentrates. It is hoped that these problems, relative to dressing, will be solved in the near future, and particularly with respect to the zinc ores obtained from Temir-Tau.

The high iron content (20 percent) in tailings is evidence of inefficient dressing methods. However it is safe to say that as a result of 11 years of Mekhanobr experiments involving the use of cation reagents, direct flotation and other methods of flotation, this problem will be solved in the near future. The Salair Lead-Zinc Dressing Plant which has one of the most effective dressing methods, nevertheless manages to allow a rather significant waste in ores.

The Salair Plant obtains its ores from the Salair deposits, which consist of about 40 separate ore bodies. These deposits are very closely related both generically and physically, thus appearing to be a single large deposit. Sulfides are found in the form of zinc, galena, pyrite, chalcopyrite and barite compounds.

The ores are dressed according to the flotation-gravitation method. The crushing is in two stages with up to 70 percent crushed to 200 mesh grade.

In the second stage the equipment is used to extract gold. Following that, lead and copper, zinc and pyrite, and barite are extracted. The zinc-pyrite extract is in turn separated into zinc concentrate and an intermediate pyrite product. Finally the plant releases for commercial use a lead-copper concentrate, a zinc concentrate, a barite concentrate and gold-bearing concentrate.

The Salair Plant was the first in the USSR to use a noncyanide method of selective-collective flotation, with a hyposulfite depressor. Results were very satisfactory. In the prewar period the factory produced zinc, barite, lead, and a copper concentrate which was acclaimed by industry. The process for extraction of the products of flotation of generically related minerals is good; however, separation, if any, of the individual minerals is poor. This is particularly true with respect to coarse zinc-pyrite concentrate and lead-copper concentrate. Pyrite products, which contained large amounts of zinc, copper, and gold, were dumped. Extraction of barite is poor, and is attributed to insufficient treatment to remove the sulfide content.

As yet Mekhanobr has not worked out a collective flotation system for this plant, but it is believed that as soon as this is accomplished there will be an elimination of all the unfavorable factors. In addition, no efficient dressing system has been developed for the Kolyvan Dressing Plant. Under present conditions this plant is able to extract only wolfram, while all the bismuth concentrate is dumped. No specific technology has been tried and no complete geological data exists on most of the other Central Siberian deposits. Work along this line will do much to increase the production of lead, zinc, copper, cadmium, aluminium and rare metals.

- 3 -

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50X1-HUM

Under conditions of complex operation it is possible to use variations of technological methods for dressing: for polymetallic copper-zinc ores it is possible to use extraction of complex industrial products with end processing according to Makobetskiy's method (GinTsvetMet); for rare metal ores after extraction of the collective gravitation concentrate it is best to pass the ore over special tables (where specific substances are added) prior to flotation. Part of the process involved autoclaving according to Maslenskii's method. It is also possible to decrease waste at factories by a more judicious processing of the coarse crushed material.

Processing of the alluvial deposits of Central Siberia, which for the most part contain valuable metals and tin, is primitive. Until very recently, dressing of ore sands was carried out exclusively by sluice boxes and riffles. It is true that properly constructed sluice boxes will extract up to 95 percent of the iron; however, where the minerals have a specific weight of 5 to 7 the sluice boxes extract only 60 to 75 percent. Recently, jigging has been introduced with satisfactory results for extracting minerals which are lighter than gold. Today this method has been accepted as the best for dressing ores from alluvial deposits.

The following system is recommended for working ore sands:

1. Sifting to separate the pieces which are plus 200 millimeters.
2. Sifting and washing of particles which are 10 to 15 millimeters.
3. Dressing in sluice boxes.
4. Precipitation and separation of tailings.
5. Concentration of the precipitate.
6. Cleaning of the lower products of concentration and return of tailings to the basic material being processed.
7. Concentration of the concentrate from the cleaning (item 6) on dressing tables and return of the tailings from dressing tables to the material which was processed in item 6.
8. Controlled sluicing of the concentration residue (item 5).
9. Mixing of the various concentrates.

One of the primary operations in processing sands is disintegration and sifting of sands to obtain a residue with particles from 10 to 15 millimeters. A drum screen is the best apparatus for this purpose. In the event that heavy minerals might be present in the ore, it is advisable that the ore be passed through sluice boxes prior to processing in the screens. The collected concentrate of the heavy minerals is sent to another factory for processing. Extraction of heavy minerals with specific weights of 5 to 7 is usually 85 percent. If concentrators are added this can be raised to 95 percent. Settling equipment has greater efficiency and productivity than the sluice boxes and therefore should be rapidly adopted by dressing plants. Mekhanobr and other institutes are working on a project to develop settling equipment which will perform satisfactorily both for heavy and light minerals.

- 4 -

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Conclusions

Contemporary methods for dressing, including the combined processes of dressing, used in metallurgical practice, permit the complex utilization of mineral resources, eliminate the necessity of shipping ores over long distances, utilize facilities to their full capacities (Kuznetsk metallurgical plants and the Belovo Zinc Plant), and guarantee a plentiful supply of iron, zinc, cadmium, gold, silver, tin, and concentrates of nonferrous and rare metals.

To bring about rapid solution of the existing problems it is necessary: (1) To conduct widespread technological and theoretical work in the fields of dressing, and mixing and metallurgy, (2) To organize efficient surveying for new deposits and scientific and research work for studying the Central Siberian deposits.

A basic technological system should be worked out which would aid in the designing of complex technological processes for fuller utilization of ore resources.

There is no doubt that the regions of the Central Siberian plain are best suited for valuable future development and the growth of Soviet metallurgical industries.

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- 5 -

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